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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue
Seattle, WA 98101

Reply To
Attn Of: OW-130

February 22, 1999

MEMORANDUM

SUBJECT: Bunker Hill Mine Water Presumptive Remedy
Comments on Memoranda

FROM: Patty McGrath, Office of Water
Environmental Engineer

TO: Mary Kay Voytilla, Office of Environmental Cleanup
Project Manager

Following are my comments on memoranda prepared in support of the Bunker Hill Mine Water Presumptive Remedy. Due to time constraints my review was focused on conceptual aspects of the mine water treatment and sludge management portions of the presumptive remedy. I did not review in detail the design elements and cost estimates presented in the memoranda. Also, I did not review the Mine Contingency Plan.

Acid Mine Drainage - Bunker Hill Mine Water Conceptual Model

- (1) General Comment: To better understand the conceptual model discussions, it would be helpful to add a topographic map that shows the surface features mentioned throughout this memorandum (e.g., Milo Creek and its forks, Deadwood Creek, Bunker Hill dam, Guy Caving area, Hooper Portal, etc.).
- (2) General Comment: At some point this memo should provide a discussion of the existing mine operations and whether or not the operations impact the conceptual model. This discussion should include:
- discuss how current mining operations effect each component of the conceptual model (e.g., intra-mine flow, surface water/ground water interactions, water quality and quantity, source of AMD, etc.) and how mine closure might impact each component
 - for the most part, the conceptual model is developed based upon historical data; discuss

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whether any changes in mining operations since collection of the historical data may impact the representativeness of the historical data for use in predicting current and future conditions

(3) Page 6, Section 3.0: Explain why monitoring was conducted on the 3 Level, 5 Level, and 9 Level only. By monitoring these locations only, are there any flows or sources of AMD that might not be accounted for? Also, it would be helpful to add a cross-section showing the relative locations of these three levels and connections (e.g., add 3 level to Figure 5-1?). It would be helpful to add some surface feature(s) to Figure 3-1, so that it is apparent where the workings are located. For example, where does the portal daylight?

(4) Pages 19 - 23, Section 5.0: This section discusses inflow mechanisms, intra-mine flow, and surface water/ground water interactions. The discussion is based on the results of past work. For each of these subsections, should state whether or not CH2M Hill is investigating further the issues and whether or not results of CH2M Hill's work to-date is confirming the historical analyses.

(5) Page 22, Section 5.3.3.2: The section states that "The source of water in the submerged workings is not clearly understood." Should state whether there are plans to evaluate this or whether further evaluation of submerged workings would make any difference to the outcome of the conceptual model and presumptive remedy. For example, if the operator of the Crescent Mine is made responsible for collecting all Crescent Mine flow, would this make a difference in the quantity/quality of AMD from the Bunker Hill Mine (or is the Crescent Mine part of the Superfund site?).

(6) Page 22, Section 5.4.1: The second sentence mentions mine water that "flows out the" West Reed Drift and flow that "comes out the" Asher Drift. Clarify, does this mean that the flow is coming "out" of the mine, or out onto other levels.

(7) Page 28, Table 3: It would be helpful to add columns to the table that identifies for each location:

- the source of the water sampled (so that it would be clear, for example, that 5WR measures the AMD produced from the Flood-Stanly workings), and
- the other water streams that contribute to the stream sampled (for example, so that it would be clear that 9KT water includes water from 9LA, 9PU, 9BS, and the New Caledonia workings)

(8) Page 32, last sentence: Could the uncertainty also be due to other sources of mine water (e.g., seeps) that are not measured by the flumes?

(9) Page 44, Section 7.0: Even though it appears that "The majority of poor quality water originates in the pyrite-rich Flood-Stanly workings", the conceptual model should also identify the other sources, especially if there are other discrete sources. Even though other sources may not be large contributors, if they can be easily isolated then their mitigation is worth evaluating.

Sections 7 and 8 indicate that the source of AMD is from the existing ore body. The AMD Collection, Conveyance, and Storage memo states that "much of the stoped areas between levels

were backfilled with tailings" and the AMD Mitigation memo describes how a portion of the Guy Cave area was filled in with tailings. Are these tailings a source of AMD? Is it possible to evaluate the effectiveness of these tailings disposal techniques as an analog for predicting effectiveness of backfilling as an AMD mitigation measure?

It would be worthwhile to add a separate section (e.g., between Section 6 and Section 7) that lists the sources of AMD. This would help to clarify how the results of the mine water flow and chemical analyses discussed sections 5 and 6 were used to identify potential mitigation measures discussed in Section 7. For each source identified, should discuss whether or not it is worth further evaluation. If sources other than the Flood-Stanly workings are determined to be worth evaluating, then this information should be carried forward into Sections 8 and 9 and the Mitigations memo.

(10) Page 44, Section 7.0: In the second paragraph, clarify what is meant by "discharge from non-point sources".

(11) Page 46, Section 8.0: Should add to each bullet, a discussion of the uncertainty surrounding the conclusion discussed in each bullet. Alternatively, an uncertainty discussion may be added to the individual subsections which support each bullet (for example, uncertainty related to the intra-mine flow conclusions would be added to Section 5.3).

(12) Page 47, Section 9.0: Other recommendations should include:

- A commitment to refine the conceptual model based on current work being performed by CH2M Hill.
- The discussion of loadings is focused on zinc, should verify that other metals follow zinc.
- potentially evaluate how sources other than the Flood-Stanly workings contribute to the conceptual model (depends upon resolution of comment 9).

Executive Summary - Bunker Hill Mine Water Presumptive Remedy

(1) Table 2, AMD Generation Mitigations: Should evaluation of the East Fork Milo Creek diversion be added to the new information needs? See comment (4) on the Mitigations memo.

(2) Table 2, AMD Treatment: This table states that evaporation and crystallization is the only treatment process likely assured of meeting the draft TMDL based treatment standards for the 7Q10 flow conditions. This statement should be qualified by adding that it is based on lack of treatability testing of other treatment technologies. A better way of putting this is to say that, for all the treatment options, treatability testing is required to determine which technologies can meet treatment goals. However, there is less uncertainty in the ability to meet low effluent concentrations utilizing evaporation and crystallization. Note that Section 4.2.5.3 of the AMD Treatment memo states that sulfide technologies have "the potential to meet the draft TMDL based treatment requirements, but testing is required." This is the type of text that should be expressed in the findings of this Table. See also comment (23) on the AMD Treatment memo in

regard to potential new information needs.

(3) Table 2, Treatment Sludge Management: Clarify, is Alternative 1 (Disposal of raw sludge in disposal beds) or Alternative 2 (Dewatering in sludge beds and onsite disposal) recommended as the presumptive remedy? Also, once an AMD treatment process is selected, the sludge produced from the process should be characterized (e.g., volume and physical and chemical characteristics, stability, etc.) to predict future sludge characteristics to assist design of the disposal beds. This should be added to the information needs.

AMD Mitigations Evaluation - Bunker Hill Mine Water Presumptive Remedy

(1) Page 2, Section 2.2: The second paragraph states that the "Flood-Stanley ore body in the Milo Creek basin is the major discrete AMD producing area of the mine." According to the text, this is based on Riley (1985). CH2M Hill should state whether or not their recent work has confirmed this. It is appropriate to focus on major sources, however, should also identify whether there are other discrete sources that could likewise be mitigated. See comment (9) on the Conceptual Model memorandum.

(2) Page 4, Section 2.2.3: The last sentence states that a portion of the Guy Cave was filled in with tailings. CH2M Hill might consider evaluating the effectiveness of this and other locations of tailings disposal in the Bunker Hill Mine, in terms of whether or not it can they be used as an analog to predict implementability and effectiveness of in-mine backfilling and/or in-mine sludge disposal.

(3) Page 7, Section 3.1: The discussion of potentially applicable technologies should also evaluate backfilling portions of the mine (e.g., around sources of AMD to isolate the source and/or to divert water).

(4) Page 9, Section 3.1.1: The last sentence states that further consideration of the East Fork Milo Creek diversion would be deferred until after evaluations were made of the South and West Fork diversions. Since the evaluations of the South and West Fork diversions indicate that they are cost-effective, should go on to evaluate the East Fork diversion (or explain why not).

(5) Page 23, Section 4.4: The recommendations and data needs should also identify the need for evaluation of effectiveness, implementability, and cost of the East Fork Milo Creek diversion and Deadwood Creek diversion.

AMD Collection, Conveyance, and Storage - Bunker Hill Mine Water Presumptive Remedy

(1) General Comment: The reason for evaluating mine water storage is to determine storage capacity and options in the event the conveyance system or the treatment plant is inoperable. May also want to consider evaluating AMD storage during times of low river flow (rather than treating and discharging) as a component of wastewater management. See comment (23) on the AMD Treatment memo.

(2) General Comment: The evaluation of collection, conveyance, and storage measures and their costs do not take into account the decrease in flow that would be a result of implementing the mitigation measures (surface water diversions) that are also part of the presumptive remedy. This memo should discuss whether or not the evaluation of the collection, conveyance, and storage measures and their costs would be substantially different with implementation of the surface water diversions.

✓ (3) Page 2, Section 1.4, Cost Estimates: It appears that some of the cost estimates in this memo are based on current mine operating costs. Should evaluate whether or not the costs would be substantially different if the mine were not operating.

(4) Page 23, Section 4.2: In the first sentence, the storage time required also depends upon AMD flow/quantity. For example, if the surface water diversions are effective in reducing the amount of AMD produced, this might change the storage evaluation.

✓ (5) Page 29, Section 5.1: The alternate AMD collection scheme (diverting mine water from the upper to the lower levels and collecting water from the lower levels) has some major advantages. The memorandum highlighted its lower costs. The other advantage is the potential of evening out the AMD strength and flow which would reduce the potential for treatment plant upsets. However, as stated in Section 5.1, this option would only be feasible if the mine were permanently closed. It is appropriate to develop the Presumptive Remedy based on the current situation (operating mine). However, it may be worthwhile to incorporate into the Presumptive Remedy a contingency plan that carries forward options that might be more cost-effective, under the mine closure scenario.

AMD Treatment - Bunker Hill Mine Water Presumptive Remedy

(1) Page 1, Section 1.0: The second paragraph states that "The new mass-based TMDLs are expected to result in much stricter concentration-based limits for NPDES discharges." The wasteload allocations (WLAs) in the draft TMDL are mass-based not concentration-based. The mass-based WLAs will be directly used as NPDES permit limits, and may or may not be translated into concentration-based permit limits. Expressing permit limits in terms of mass, rather than concentration, should help encourage recycling and source control. The Bunker Hill facility does not have an NPDES permit. Therefore, the treatment goals should be based on the mass-based TMDL WLAs and the effectiveness evaluation should take into account mass reductions as well as final predicted effluent quality.

It would be worthwhile to add a discussion of the relationship between the mass-based TMDL WLAs and effluent concentrations. The translation between mass and concentration depends upon effluent flow. If effluent flow is decreased, then concentration goals increase (this should provide added incentive for implementing the surface water diversions and other measures to reduce hydraulic loading). See also comment (7).

It would also be worthwhile to add a discussion of the relationship between total and dissolved metals. The most recent TMDL calculates WLAs as total metals based on a site-specific translator. The translator was 1 for cadmium and zinc throughout the South Fork Coeur d'Alene. The lead translator varied with target site.

(2) Page 3, Section 1.4: Should also identify that the cost estimates assume no mine water diversion.

(3) Page 4, Section 2.0: Clarify why the plant is operated in the LDS mode.

(4) Page 8, Section 2.1.2: "...the flocculation basin is also full of sludge up to 6 inches below the surface..." Are there plans to clean this out (maybe concurrent with cleaning the lined pond)? Would this improve the effectiveness of flocculation, hence settling, hence lower levels of metals in the discharge?

(5) Page 9, Section 2.1.4: It is unclear why it is necessary to operate the thickener as a clarifier to meet discharge limitations. Is it because the plant is operating at greater than its design capacity, or was the design based on achieving some higher discharge limits?

(6) Page 10, Section 2.2 and Table 3: "The current NPDES permit discharge requirements...". Should clarify that the Bunker Hill Mine does not have a current NPDES permit. The permit expired and was not reissued due to the Superfund status of the site.

(7) Page 10, Table 4: This table and associated text should be revised as follows:

- Update the WLAs to reflect the most recent draft TMDL WLAs. For example, the 7Q10 WLAs in the most current version (January 4) of the draft TMDL are approximately twice that shown in Table 4.

- Clarify that the TMDL WLAs are expressed as mass loadings (lb/day) and that these mass loadings are the treatment goal. The TMDL will not specify concentration limits. The expression of the WLAs as concentration depends upon the flow, therefore should state what flow value(s) was used to calculate the concentrations in Table 4. Also, it is worth determining the correlation between AMD flow and river flow conditions. If AMD flow follows river flow, such that effluent flows are lower during the low flow river conditions, then these lower effluent flows may be used to calculate effluent concentrations for the respective flow tiers. This would result in higher concentration numbers for the lower flow tiers than those shown in Table 4.

(8) Page 11, Table 5: Add copper to the data in Table 5.

(9) Page 12, Table 6: Iron co-precipitation should be added to the technology screening list.

(10) Page 14, Section 3.2.1: Even the promising innovative technologies are screened out, apparently because they are innovative. For example, the biosulfide process is screened out since it has not been demonstrated at full-scale. However, it has been demonstrated at pilot scale. It may be worthwhile contacting the vendor for a cost estimate, and if costs are lower than

chemical sulfide precipitation, request that the vendor conduct a treatability test (the vendor might do it for free). If estimated costs are not less than chemical sulfide precipitation, then use of the biosulfide process is not worth evaluating.

(11) Page 16, Section 3.2.4: "Insufficient data was developed during the testing to demonstrate effectiveness" of the KEECO process. Did CH2M Hill contact KEECO to verify this?

(12) Page 16, Section 3.2.6: The discussion of the metals recovery process developed by the University of Idaho should be moved to the section on sludge.

(13) Page 17, Section 3.2.7: "...since the HDS process has been demonstrated to be effective on the site AMD." How is "effective" defined? Comparing the values in Table 10 for the HDS plant trial with the values in Table 3 does not indicate that the HDS process was effective.

(14) Page 18, second paragraph: Correct the first sentence, the CTP does not currently use the HDS process.

(15) Page 25, Section 4.2.1.3: The effectiveness of the HDS process was evaluated based on average effluent quality produced during the 1997 HDS trial study. Should discuss how effective the study was at really evaluating HDS (particularly since Table 10 indicates that the average effluent quality was worse when operating under the HDS mode than the LDS mode). See also comment (13).

(16) Page 28, Table 10: Two comments on this table:

- As recommended in comment (7) update the table so that the concentration goals are based on the most recent TMDL WLAs. Also the most recent TMDL calculates WLAs as total metals based on a site-specific translator. The translator was 1 for cadmium and zinc throughout the South Fork Coeur d'Alene. The lead translator varied with target site.

- According to the table footnote, the estimated average effluent for alternatives 6a and 6b was based on 1998 full-scale data from the Red Dog Mine. However, effluent data from the Red Dog Mine indicates lower concentrations of lead and zinc than shown in the table (on the order of 8 ug/l for lead and 40 - 50 ug/l for zinc).

(17) Page 30, Section 4.2.2.3: "The estimates are based on the assumption that 95 percent of the TSS...". According to Table 10, 98 percent removal was assumed. Correct this discrepancy. Also, should state the basis for the TSS removal assumption (e.g., was it based on work on similar projects?, vendor estimates?, etc.).

(18) Page 32, Section 4.2.3.3: "...the effluent quality by polishing with HDS effluent with micro-filtration will be the same as from a multimedia filter." Table 10 indicates that effluent quality would be different. Correct this discrepancy.

(19) Page 34, Section 4.2.4.3: The text states that iron co-precipitation is likely to be as effective as sulfide precipitation. This may or may not be the case. Although it is accurate to say

that the level of magnitude effectiveness would likely be similar, treatability testing is necessary to more accurately determine and compare effectiveness of these technologies. Likewise, without treatability testing it is not clear whether or not the alternative will meet the low flow WLAs.

(20) Page 38, Section 4.2.5.3: With sulfide precipitation, "...effluent cadmium and lead may reach sub-ppb levels and effluent zinc is expected to be below 5 ppb." Yet the Table 10 data for this alternative (4a and 4b) indicates much higher levels of lead and zinc. Correct this discrepancy.

(21) Page 42, Section 4.2.7.3: "...data from the Cominco Red Dog Mine showed that their approach would not meet the draft TMDL based treatment requirements". See comment (16). The Red Dog data in Table 10 for lead and zinc are high. It should also be noted that the Red Dog mine water plant is operated to meet their permit limits, if stricter limits were in place (e.g., on the order of the low flow WLAs) then the plant may have been adjusted to meet the lower limits.

(22) Page 48, second paragraph: "...although the only option likely assured of being able to meet the draft TMDL based..." Should qualify that this statement is based on no treatability testing of the other options.

(23) Page 48, Section 4.4: Several comments on the recommendations:

- Agree that treatability testing is needed to determine whether or not the sulfide precipitation and iron co-precipitation technologies can achieve the draft TMDL low flow WLAs. However, until this testing is completed, I do not agree with the assumption that these technologies combined with filtration cannot meet these numbers. It is more accurate to say that we just don't know until site-specific treatability testing is performed.
- I recommend a tiered approach to treatability testing, where the lowest cost options (sulfide precipitation and iron co-precipitation) are tested first under a range of conditions.
- Should add to the recommendations the need to determine how reductions in flow impact the calculation of concentration-based treatment goals and how this might impact selection of a treatment option.
- Add to the recommendations, the need to determine how effluent flow relates to receiving water flow. If there is a correlation, calculate new concentration goals based on the representative effluent flow for each flow tier.
- At several places in the text and in the recommendations, it is stated that some of the technologies evaluated might be able to meet the draft TMDL WLAs, except for the low flow levels. It is worth evaluating the option of not discharging during these low flow times. This technique is used by some existing active mines to ensure that they meet permit limits (i.e., they only discharge when there is a certain level of flow in the receiving water). This would require evaluation of the ability to store AMD during low flow periods and how it might impact/increase

flows during times when there is a discharge. If this type of wastewater management is an option, then reduction in flow (i.e., the surface water diversions) becomes even more important.

Sludge Management - Bunker Hill Mine Water Presumptive Remedy

(1) General Comment: As was done for the AMD Treatment memo, provide a brief description of current sludge management practices so that it is clear why other options need to be evaluated.

(2) Page 3, bullets and page 4, Table 2: Provide the basis for the assumptions listed in the bullets (this was done for the last two bullets only) and in Table 2.

(3) Page 7, Section 3.1.1: At the beginning of this section, should provide rationale for why disposal into, specifically, Raise No. 3 is evaluated. Why was Raise No. 3 selected? What about other areas of the mine or lower workings? If volume is an issue, what about in-mine disposal into many different areas of the mine? Should also discuss whether this disposal option is influenced by the status of mining operations.

(4) Page 11, Section 3.1.1.5: Two comments on this section:

- The effectiveness discussion of in-mine disposal notes that there is the potential for dissolution of metals from the sludge. Should discuss whether there are amendments that could be added to the sludge to inhibit dissolution.
- It might be worthwhile to evaluate whether other mines have disposed of sludge within the mine and what the implementability and effectiveness issues were.

(5) Page 17, Section 3.2: An additional advantage of sludge dewatering is that sludge disposal area requirements are lower.

(6) Page 26, Section 3.2.2.5: The discussion of sludge drying beds should indicate how long it will take to achieve the 60 percent solids and effectiveness/implementability issues associated with precipitation onto the drying beds.

(7) Page 26, Section 3.3.1: As requested for the in-mine disposal of sludge, provide rationale for why the Hanna Stope, in particular, was selected for in-mine disposal of dewatered sludge.

(8) Page 30, Section 3.3.1.5: See comment (4).

(9) Page 48, first paragraph: A metal recovery plant for AMD treatment does not necessarily have to operate at a profit. Cost effectiveness should be evaluated in comparison to the difference in cost between conventional water treatment and the cost of the metal recovery plant minus the cost from sale of metals.

(10) Page 48, Section 3.4.2: Processing of raw AMD should be moved to the AMD treatment memo.

(11) Page 49, Sorptive Processes: "The discharge criteria for treated water from the Bunker Hill

Mine are currently being developed, so it is not known if water from the IBC ion exchange process would be suitable for discharge." Compare the IBC numbers to the draft TMDL WLAs as was done for the other AMD treatment options.

(12) Page 56, Section 4.3: Two comments on this section:

- This section identifies the two lowest cost alternatives, but does not discuss which one is part of the presumptive remedy. Also, it is not clear whether the presumptive remedy is recommending Alternative 1 or Alternative 2.
- As was done for the other memos, add a section with recommendations regarding any additional work that should be done for determining sludge management.

Cost/Benefit Analysis - Surface Water Diversions Bunker Hill Mine Water presumptive Remedy

(1) Page 9, fourth paragraph: See comment (2) on the Executive Summary memo.

(2) Page 10, second paragraph: An additional benefit of reducing the flow of AMD that needs to be treated is that it allows for more flexibility in wastewater management. See comment (23) on the AMD Treatment memo.

(3) Page 10, Section 5.0: CH2M Hill recommends evaluating the Deadwood Creek diversion. Should also consider evaluating the East Fork Milo Creek diversions as discussed in the Mitigations memo (see comment (4) on the Mitigations memo).